Introduction

Problem Statement:
- An affordable and reliable form of transportation is lacking in many rural communities in Sub-Saharan Africa
- The team has been tasked with optimization of the PUP driveline and frame for manufacturability, safety, and performance

Background:
- Purdue has partnered with ACREST, a NGO located in Cameroon to provide an affordable vehicle for local transportation of people, water, crops, and supplies
- Local road conditions limit transportation
- Current motorized transportation options incur large capital costs and maintenance costs
- The PUP can carry 2,000 lbs, traverse rough roads, and is manufactured locally in Africa, making it affordable to the community
- Using only locally available parts and materials allows the PUP to be a sustainable vehicle for future manufacturing in the micro-factory setting

Impact on Society
- Team will travel in May to reproduce design in Cameroon using only locally available resources
- The PUP will be used on a day-to-day basis by ACREST hauling people, food, water, crops, supplies, etc.
- The vehicle will reduce small-holder farmer labor and frame for manufacturability, safety, and performance
- Replacing this design locally on a micro-factory
- The vehicle will reduce small-holder farmer labor and frame for manufacturability, safety, and performance

Project Goals
- Optimization of truss-style frame to reduce total number of parts and decrease CG by lowering height of bed
- New engine placement to prevent theft, reduce noise & emissions to operator
- Develop a high-flow gearing option for transportation or agricultural mechanization
- Explore alternative clutching mechanisms for ease of manufacturability in Africa
- Manufacture prototype to test at Purdue and to compete in an endurance event

Alternative Solutions

Engine Placement:
- Engine configurations under the driver’s seat, in the cargo bed, and directly in front of the transmission were explored
- Criteria for safety, noise, and theft prevention were considered for final choice

Trailing Arm:
- V-arm and X-arm design compared, X-arm experiences less concentrated stress

Clutching Mechanism:
- Tiliting the engine to decrease the center to center pulley distance was tested and belt continued to slip while experiencing heavy loads under full tension

Final Design
- Frame made entirely from a common size angle iron
- Bed lowered 3.7 inches (Lower center of gravity)
- Trailing arm length shortened 11 inches
- Roll stiffness increased by moving springs farther from roll center
- Engine under passenger seat to reduce emissions and noise to operator
- Clutching mechanism utilizes pinned angle iron linkages and idler pulley system

Vehicle Specifications
- Wheelbase: 103 in
- Vehicle Length: 144 in
- Vehicle Width: 50 in
- Cargo Bed Volume: 21.5 ft³
- Unloaded Weight: 1240 lbs
- Rated Payload Capacity: 2000 lbs
- Front Suspension: 4 coil springs (115 lb/in each) & 2 shocks
- Rear Suspension: 4 coil springs (115 lb/in each) & 2 shocks
- Transmission: 4 speed with reverse, (1989 Toyota truck)
- High Option: 3rd 13.9 368.6
- Low Option: 1st 3.4 1496.8

Final Drive Options

<table>
<thead>
<tr>
<th>Gear</th>
<th>Vehicle Speed (mph)</th>
<th>Tractive Force (lbf)</th>
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<tbody>
<tr>
<td>1st</td>
<td>3.4</td>
<td>1496.8</td>
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<tr>
<td>2nd</td>
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<tr>
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Cost Analysis
- Engine: 10 HP single cylinder diesel engine $625.00
- Clutch: Angle iron linkage with idler pulley $80.00
- Final Drive: Rear Differential 3.071:1 reduction (1989 Toyota truck) $250.00
- Transmission, Driveline, Rear Axle, Mic. Parts $200.00
- Rim & Tires $-\$-\$-
- Brake cylinder and lines $60.00
- Lights, Driver Controls, Handlebars, Pedals $30.00
- Transaxle: $200.00
- Frame made entirely from a common size angle iron $300.00
- Misc. Components/Tools/Supplies $275.00
- Plywood $75.00
- Springs (4) $60.00
- Misc. Parts $200.00
- Transmission, Driveline, Rear Axle, Mic. Parts $200.00
- 1989 Toyota Pickup Truck for parts $600.00
- Total $1,675.00

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- Dr. John Lumkes
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Sponsor(s): Vincent Kitio, ACREST
Technical Advisor: Dr. John Lumkes

PROJECTS IN PRACTICE
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